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AIR CARGO INSULATION STUDIES WITH FLOWERS

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Air Cargo Insulation Studies With Flowers

The quality of cut flowers may suffer a great deal from prolonged exposure to unfavorable temperatures. When flowers are shipped by air during cold weather they may encounter freezing temperatures aloft as well as during ground stops and handling and hauling to and from the airport. Also in hot weather overheating may cause spoilage or otherwise shorten flower life.

The purpose of this investigation was to determine the feasibility of protecting boxes of commercially packed cut flowers in cold and warm weather by covering them with an auxiliary blanket of light weight insulating material. The insulating effect of several different box liners was also observed.

A block of 12 boxes protected by the blanket and a stack of 4 boxes left "exposed" without auxiliary covering were subjected to low temperatures in one test and to high temperatures in a second test. A large decompression chamber was used in which altitudes encountered in transcontinental flights could be simulated. The results showed that the blanket gave good protection against freezing, and also protected the flowers from rapid warming and overheating during prolonged exposure to high temperatures. The liners regularly used in the boxes had some insulating value as indicated by small temperature differentials between blanketed and non-blanketed boxes during the first 2-hour exposure but the differential increased quite rapidly thereafter in favor of the blanketed lot.

Close comparison of the insulating value of box liners could not be made within the limits of this test, however it appeared that the insulating property of newspaper and other fibrous materials used in boxes of cut flowers was small, probably because they became damp. It also appeared that aluminum foil with its moisture barrier and heat reflecting properties may have some value in protecting flowers from freezing when this material is used as a box liner. It was of less value in protecting the boxes from heat in these tests.

Test Procedure

The packed flowers were obtained at the Los Angeles wholesale market through the cooperation of the Southern California Floral Association. Flight conditions were simulated in the decompression chamber of the Lockheed Aircraft Corporation at Burbank.

The flowers were packed as mixed lots in 9" x 15" x 36" corrugated fiberboard shipping boxes containing package ice consisting of a 5-pound cake of water ice wrapped in newspaper and tied to the center cleat of the box. Fig. 1. Most of the boxes were lined with 5 layers of newspaper which is customary for winter shipments. Other liners tested were 1/4" Kimpack and 1/2" fiberglass, (2 boxes each). In addition, two boxes were lined with thin aluminum foil (one layer .0015" thick) to test the heat reflecting value of this material for packed flowers.

Each box contained about 15 pounds of flowers consisting of 6 bunches of stock and one or two bunches each of fern (Sword), anemone, carnation, calendula, daffodil, ranunculus, sweet pea, and a few stems of snapdragon. The shipping box, packing material, and ice weighed about 10 pounds making the total weight of the packed box approximately 25 pounds. A few "tailored" gardenias and Vanda Joaquin orchids were exposed to low temperature at high altitude to observe freezing injury but none were included in the boxes of packed flowers.

The decompression chamber used to simulate flight conditions was cylindrical in shape and approximately 6 feet in diameter and 10 feet long. It was insulated and had observation windows along the side and in the end. The temperature, humidity, atmospheric pressure, and rate of increase or decrease in pressure could be controlled to simulate actual flights. Thermocouples installed in the chamber were connected with a temperature indicator (potentiometer) outside the chamber.

The insulating blanket (2 pieces) consisted of a bottom pad 40 inches wide and 54 inches long and a fabricated cover consisting of 4 sides and a top that would cover a load about 3 feet wide, 4 feet long, and 4 feet high, Fig. 2. The blanket was about 1" thick and weighed about 20 pounds or .215 lbs./sq. ft.

The chamber was loaded with 16 boxes of flowers separated into two blocks. Block A contained 9 boxes with newspaper liners and 1 box with each of the other liners and was covered with the blanket. Block B consisted of a pile of 4 boxes (1 with each kind of liner) and was left uncovered. Each of the boxes in Block B had a different kind of liner and was separated in the pile by wooden spacers to allow free circulation of air on all sides.

The temperatures of flowers inside the boxes were obtained by means of a thermocouple inserted into a tight mass of blossoms (stock) about 2 inches from the end of each box. Additional temperatures were taken near the center of some boxes with thermocouples inserted into flower stems (stock) 2 to 4 inches away from the ice pack. Air temperatures were taken at points outside and inside the blanket at the bottom, side, and top of Block A and near the side of "exposed" Block B. The ambient air shown in the temperature charts is a smoothed curve representing the average of the air temperatures taken at these exposed points. At times there was considerable difference in the air temperature at the various points due to the air circulating system used in the chamber.

The test conditions in the decompression (altitude) chamber were as follows:

	Low Temperature Test	High Temperature Test
Flower temperature, Initial:	50° - 55°F.	35° - 50°F.
Ambient Air, Initial:	74°F.	55°F.
do. Lowest or Highest	-2°F.	95°F.
Altitude:	20,000 ft.	20,000 ft.
Rate climb/descent:	2,000 ft./min.	2,000 ft./min.
Flight Cycle:	Four, 2-hour "flights" for each test with short stops at sea level between each flight.	

After completion of the low temperature test the boxes were held undisturbed in the chamber "at sea level" until the following day when the same setting was used for the high temperature test.

Results

The arrangement of the boxes in the test and the temperatures of the flowers taken at 2-hour intervals are shown as part of figure 3, (low temperature test) and figure 4 (high temperature test). Cooling and warming rates are shown for protected and exposed boxes of flowers. Air temperatures inside and outside the blanket and the altitude or "flight" cycle are also given in figures 3A, 4A.

Low temperature test

During the low temperature test the ambient air dropped from 74°F. to -2°F. in 2 hours and remained close to 0° thereafter. There was very little change in the temperature of the flowers in either block of boxes from the initial 55° during the first 2-hour period. During the next 6 hours the rate of cooling of the flowers under the blanket (Block A) averaged about 3 degrees an hour compared with 4 degrees an hour in the exposed boxes (Block B) Fig 3A. In general the more exposed corner boxes of Block A cooled faster than those that were protected on 3 or 4 sides by the rest of the pile. The rate of cooling also varied with the hours of exposure to low temperature air because of the decreasing differential between air and commodity temperature as cooling progressed and the release of heat of fusion in those boxes in which frost formed at some time during the last 4 hours of the test. Temperatures at points near the middle of the boxes averaged about 2 degrees warmer after 4 hours and 5 degrees warmer after 8 hours than those near the end of the boxes closest to the outside of the pile.

The air close to the inner surface of the blanket cooled to 32° in about 3 hours and since the blanket was held in close contact with the boxes by the tie ropes there was little air space to retard the loss of heat from the outer layer of flowers to the blanket. It seems probable that increasing the air space between the blanket and the boxes by using stripping material on all sides of the block of boxes would have increased the effectiveness of the blanket as an insulating medium.

In blanketed Block A freezing apparently started in about 7 hours. There was no temperature below freezing at the end of 6 hours whereas in exposed Block B flowers in 2 of the 4 boxes were 30.5 and 31.5°F. The temperature records indicated that freezing started after about 5 hours in the boxes lined with newspaper and other pad type material while in the foil lined box freezing was delayed an additional hour. Frost extended 2 inches to 5 inches in from the sides of the boxes at the end of the test injuring the terminal buds of snapdragon and stock as well as the exposed petals of the other flowers and the tips of the more hardy ferns.

Although it was impossible in this test to make a close comparison of the insulating value of the different box liners, the results indicate that the heat reflecting property of aluminum foil might be useful in protecting packed flowers from freezing. The relatively low insulating effect of the newspaper and pad liners was probably due to the wetting of the liner by water present inside the package which resulted in thus reduced thermal resistance.

High temperature test

During the high temperature test the ambient air rose from about 55°F. to 90°F. in 2 hours and held between 90° and 95° for the remainder of the test. The initial temperature of the flowers ranged from 35° to 38° in boxes in the bottom layer of the stacks and from 46° to 50° in the boxes in the top layer, Fig. 4. During the first 2 hours the flower temperature in both blocks of boxes rose about 6 degrees from an average initial level of 42°. Thereafter the flowers under the blanket (Block A) warmed up considerably slower than those outside the blanket (Block B), as shown in Fig. 4A.

Stem temperatures near the ice in the middle of the boxes under the blanket (Block A) averaged 42° in the top layer boxes and 35° in the bottom layer boxes at the start of the test. The subsequent rise in temperature in this part of the box was only 5 degrees in 4 hours and 8 degrees in 8 hours compared with approximately 10 degrees and 20 degrees respectively at points near the end of the box. The rate of warming of the top and bottom boxes was nearly the same despite the difference in initial temperature.

Since the flowers used in the high temperature test had been used previously in the low temperature test with resultant freezing of some flowers it was impossible to evaluate heat injury closely. No discernible heat injury was found and the records indicated that abnormally high temperatures did not occur in either block of boxes.

There was little difference in the rate of warming of the boxes with different liners during the first four or five hours of the test before the package ice was depleted. Subsequent difference in the rate of warming of the various boxes apparently was affected more by the lack of package ice than by the type of liner used in the box.

Acknowledgments

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The Southern California Floral Association, Walter Swartz, Manager, and the United Wholesale Florists of California for supplying and packing the flowers.

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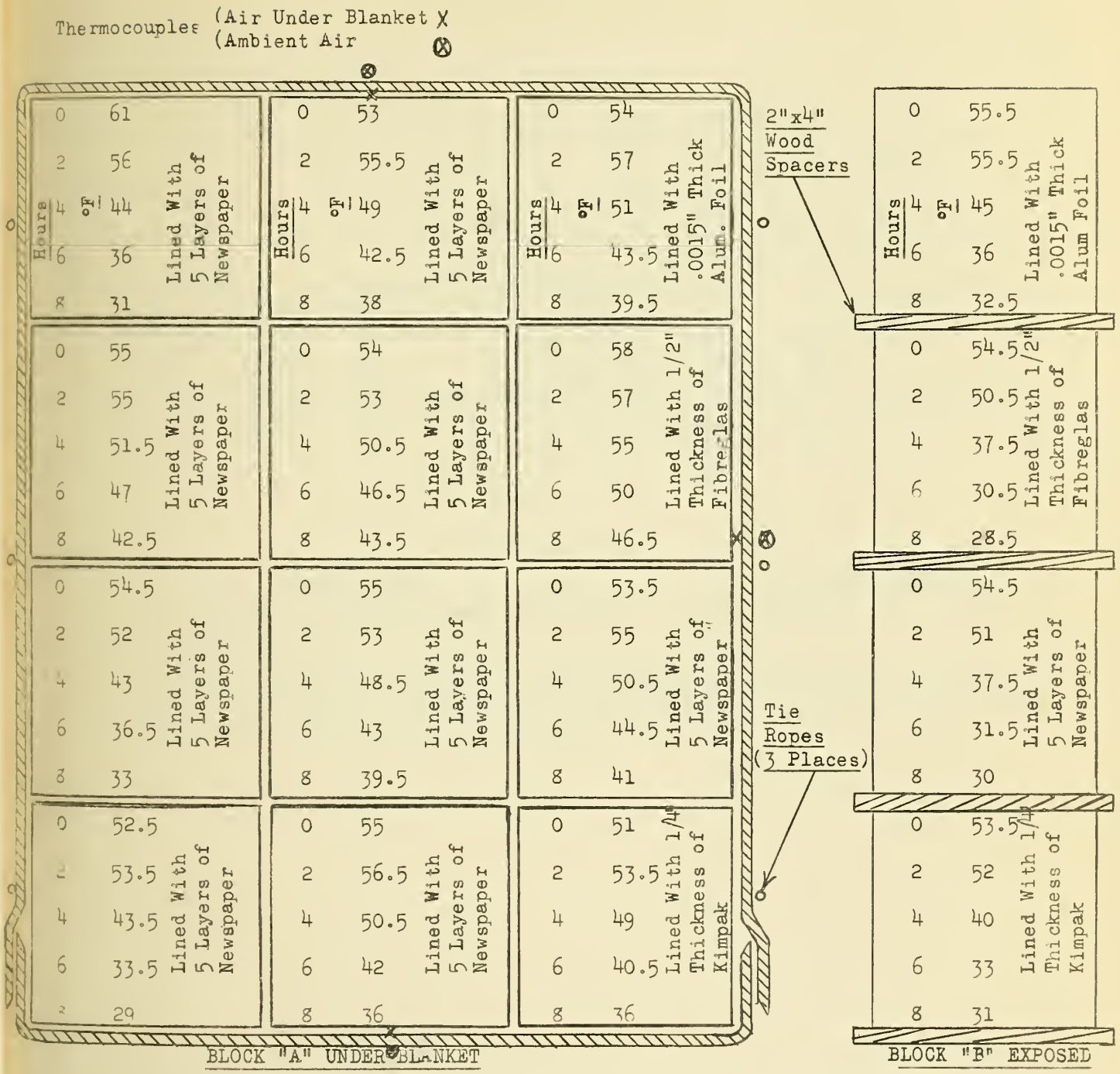
FIG. 1. (26-441 R) A 9" X 15" X 36" FLOWER BOX LINED WITH KIMPACK ABOUT 1/4" THICK

FIG. 2. (26-446 R) VIEW OF INSULATING BLANKET USED TO COVER A BLOCK OR LOAD OF 12 BOXES OF FLOWERS (3 PILES OF 4 BOXES EACH). THE BOTTOM PAD WAS FOLDED UP A FEW INCHES UNDER THE TOP PAD AND SECURED WITH TIE ROPES.

FIG. 3. SUMMARY OF LOW TEMPERATURE TEST DATA.
ALTITUDE TESTS ON FLOWERS - INSULATING BLANKET

SUMMARY OF LOW TEMPERATURE TEST DATA

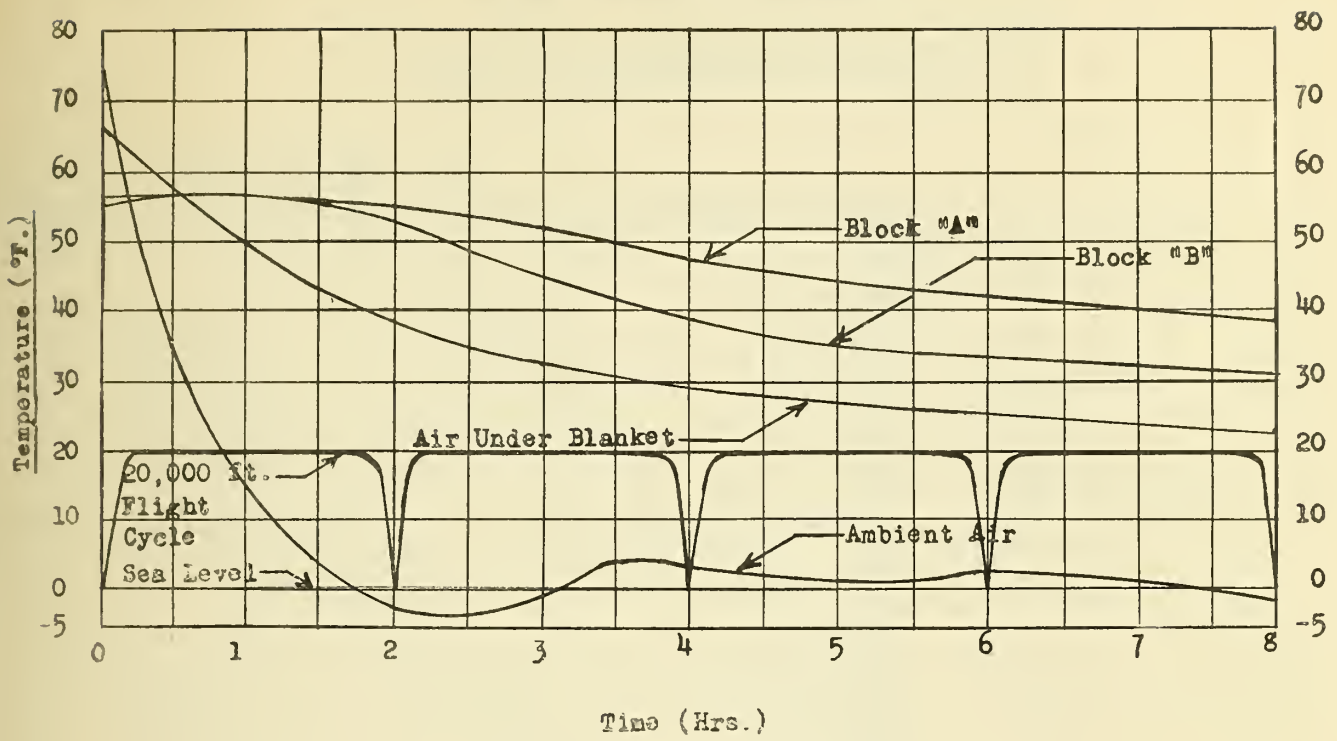


Blossom Temperatures Inside Standard 9" x 15" x 36" Corrugated Fibreboard Shipping Containers.

Insulating Blanket (2 piece) 40" Wide, 54" Long, 48" High. Outside: Single Coated Sceptum Cloth, Vinyl With Aluminum Pigment Coated on Flame-Proof Muslin. Center: "Hitco 300" 1" Thick Fibreglas. Moisture Barrier: One Layer "K" Film, .0015" Thick. Inside 126 VG Double Coated.

Fig. 3A

Average Temperatures Vs. Time



BLOCK "A" UNDER BLANKET BLOCK "B" EXPOSED

Blossom Temperatures Inside Standard 9" x 15" x 36" Corrugated Fibreboard Shipping Containers.

Insulating Blanket (2 piece) 40" Wide, 54" Long, 48" High. Outside: Single Coated Sceptum Cloth, Vinyl With Aluminum Pigment Coated on Flame-Proof Muslin. Center: "Hitco 300" 1" Thick Fibreglas. Moisture Barrier: One Layer "K" Film, .0015" Thick. Inside 126 VG Double Coated.

FIG. 4. SUMMARY OF HIGH TEMPERATURE TEST DATA.
ALTITUDE TESTS ON FLOWERS - INSULATING BLANKET

SUMMARY OF HIGH TEMPERATURE TEST DATA

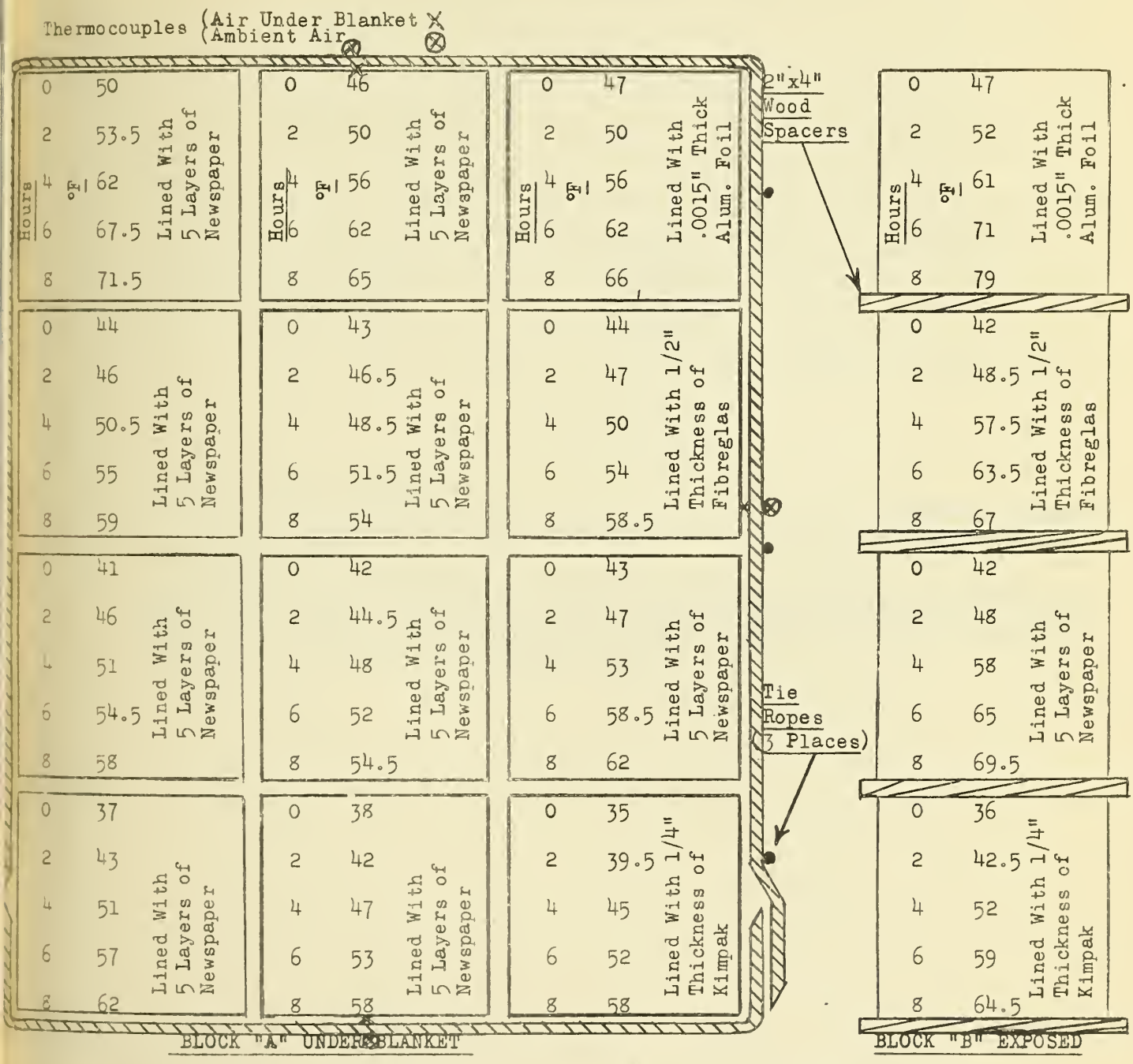


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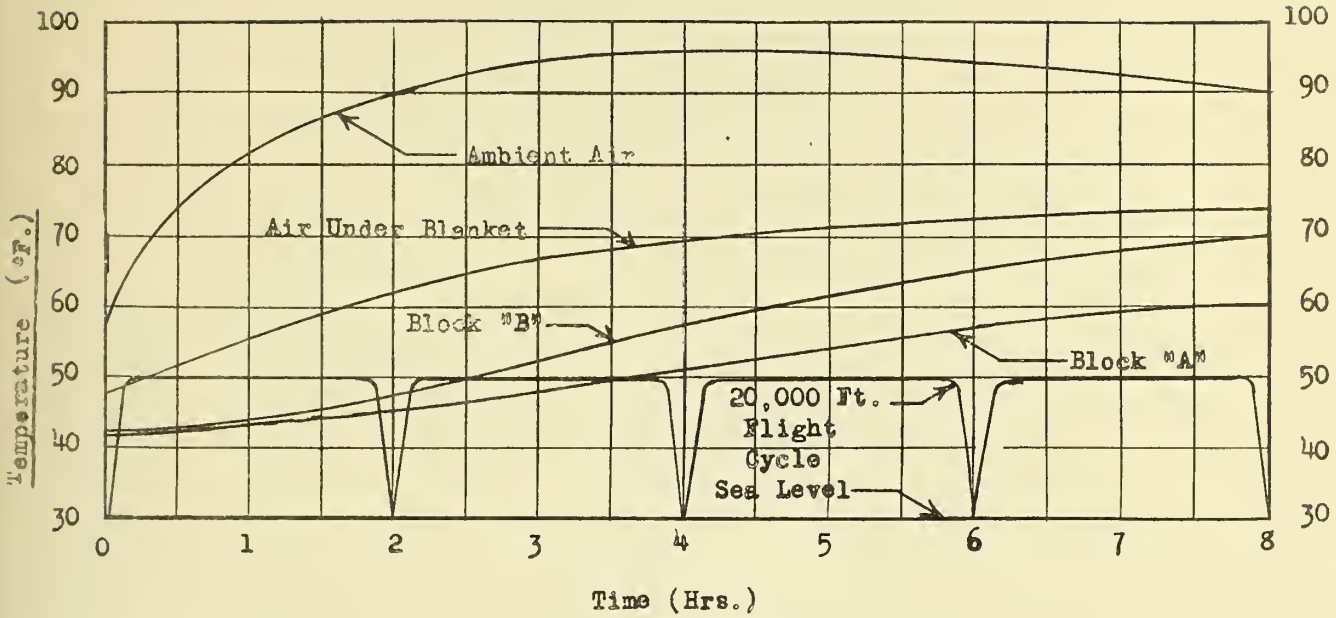
Fig. 4A

Average Temperatures Vs. Time



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